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PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Method and Apparatus for the Application of Surface Coatings

We, WESTINGHOUSE ELECTRIC CORPORATION of 3 Gateway Center, Pittsburgh, Pennsylvania, United States of America, a Corporation organised and existing under the Laws of the Commonwealth of Pennsylvania, in the United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to the art of coating the surfaces of articles and has particular relationship to the coating of the internal surfaces of articles having holes or cavities.

Typical of such an article in the stator core of a motor or generator. The stator core is of generally cylindrical form and has radial slots. The conductors through which the field current passes are wound on the teeth defined by the slots and it is necessary that these conductors be insulated. It is a requirement in the manufacture of motors or generators that a reliable integral insulating coating be applied to the walls of the slots and it is an object of this invention to provide a process or method and apparatus for meeting this demand.

Typically the insulation is to be applied to the cores of fractional horse-power motors. Such cores may be of the shaded-pole and/or split capacitor induction type and may range in dimensions from 4-7/8 inch outside diameter by 3/4 inch wide to 6-1/4 inch outside diameter by 2-1/2 inches wide. The weights of the cores may range from one pound to ten pounds and such cores may have 6, 24, 36 or 48 slots. The coating of a core imposes a condition not usually encountered in the coating of other recessed articles: that the deposit of coating on surfaces other than the surfaces carrying the winding is to be prevented.

In addition to the above mentioned typical articles to which this invention applies, it is applicable to articles of other types such as inside-out stator cores, universal motor rotors and stators. In its broader aspects this invention is applicable to the coating of articles of all types.

In accordance with the teachings of the prior art, coating is applied to the surfaces of the cavities or slots of an article by an applicator which is inserted in the slots. This apparatus is cumbersome and costly; difficulty and delay is involved in inserting, removing and cleaning the applicator. Since the coating must be fused onto the surfaces of the cavities, the temperature of the article is above the melting temperature of the coating. The coating then tends to adhere to the applicator and obstruct the removal of the applicator from the slots.

It is, accordingly, a specific object of this invention to overcome the above-described difficulties. It is a further specific object of this invention to provide a process and apparatus, not involving the above-described difficulties, for applying reliable integral coating to the walls of the cavities of an article having slots or cavities and particularly for applying such an insulative coating to the walls of the winding slots and teeth of the core of a dynamoelectric machine.

Another specific object of this invention is to provide apparatus for applying an integral coating to an article having cavities, which apparatus shall include provisions for readily subjecting these cavities to the coating material.

Still another object of this invention is to provide for apparatus for coating the internal

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surfaces of an article having cavities, mounting means for the article which shall facilitate the application of the coating.

A still further specific object of this invention is to provide a method and apparatus for applying reliable, integral, insulating coating to the winding surfaces of a core of dynamoelectric machines while preventing the deposit of coating on other surfaces of this core. An ancillary object of this invention is to provide a novel core structure which shall improve the economy of depositing coating in the practice of this invention.

In the practice of this invention the article is coated by being subjected to a fluidized powder of coating material. The prior art relating to the coating of articles by means of a fluidized powder has concerned itself primarily only with the coating of imperforate articles, or articles free of cavities and not recessed or cavity containing articles. The art teaches that imperforate articles may be coated by moving the article, completely immersed in the powder, back and forth in the powder or by vibrating the article so immersed. It is one of the specific objects of this invention to provide a method and apparatus for coating a perforate or recessed article in a fluidized powder.

In accordance with a specific aspect of this invention the recessed article is partly immersed in the powder with the surfaces of the cavities in the portion of the article submerged so oriented that the powder may readily flow through these cavities washing their walls. The article is then rotated in the powder so that during some part of the rotation substantially all surfaces of the cavities are accessible to be washed by the powder in the same way. In addition, the powder is circulated through the cavities by an air blast so that it does not at any point or in any region accumulate on the surface of the article. The circulation is effected by blowing air in and around the cavities. It is emphasized that this process of partly immersing and rotating the article, while circulating the powder in the cavities, presents a particularly advantageous solution of the problem of coating internal or cavity surfaces of an article such as a stator core of a motor. If the practice taught by the prior art were followed it would be necessary to tumble the article in the powder in a complicated manner so as to achieve the coating of the internal surfaces of the cavities. Such tumbling motion would be highly complex and would require highly complicated apparatus.

For cores for fractional horse-power motors of the type described above, the coating is typically epoxy resin which may be derived from powder of polymeric epoxides. Typical powders are disclosed in United States patent 3,039,987 for Pulverulent Coating Compositions Adapted for use in Fluidizing Process Containing Epoxy Resin and Fillers, granted June 19, 1962 to Irving M. Elbling and assigned to Westinghouse Electric Corporation. Suitable powders may be bought from Armstrong Resins Corporation, Minnesota Mining & Mfg. Co. and Westinghouse Electric Corporation. A powder suitable for the above described typical cores is Armstrong E290 series.

In selecting a powder consideration should be given to the demand that the powder material must melt and flow sufficiently to coalesce without running; that is, the flow of the melt from the powder particles should be localized so that the particles coalesce without running.

Typically, the coating powder is a blend of the basic epoxy resin, a catalyst, a filler, a material which improves viscosity and, usually, a coloring agent. The basic epoxy resin is derived from epichlorohydrin and bisphenol. A typical such basic resin may be procured from Shell Oil Company and is designated Epon 1000 1001 or others of the 1000 series. The filler may be a material like calcium carbonate. A typical catalyst for coating is an acid anhydride. The mesh size of the powder is preferably so that it passes through a sieve having 40 openings per linear inch.

It is essential that the viscosity be such that once the coated article is removed from the coating chamber the coating shall be substantially solid and free of any appreciable tackiness. One of the important features of this invention is the acceleration of the solidification of the coating by continuing to blow air onto the coated surfaces after the article is separated from the fluidized powder.

This invention contemplates within its scope apparatus for coating recessed articles. This apparatus includes a fluidized bed which in the practice of this invention is raised to submerge the article being coated partly and then lowered after the coating process is completed. To facilitate the partial submersion of the article the fluidized bed is in accordance with this invention made up of two parts joined by a rubber boot. The lower part includes a tank of steel or like material with a porous ceramic bottom plate through which the fluidizing air is projected. The upper part is also composed of a steel or the like. The boot joins the two parts and flexes when the lower part is raised to submerge the article being coated or lowered.

The apparatus according to this invention also includes a rotatable stud or mandrel of a flexible material such as rubber on which the article is mounted for coating. This mandrel serves to rotate the article in the fluidized powder and also to mask the inner bore of the article. This apparatus also in-

cludes a peripheral masking and clamping unit which comprises a pair of rings; one on the shaft of the flexible mandrel and the other coaxial with this shaft but axially movable in and out of engagement with the first ring. In the use of the apparatus the rings are separated and the article is mounted on the rotatable stud; the rings are then urged into clamping relationship over the article, after being heated to a temperature above the melting temperature of the powder. In addition the flexible stud is expanded or bulged out in the bore of the article so that it engages the bore firmly. The inner peripheries of the rings include O-rings so that this outer periphery of the article being coated is sealed against the penetration of powder. There are usually three such O-rings; one each in the inner periphery of the clamping rings and one between the clamping rings in the clamped position. The apparatus according to this invention also includes nozzles mounted adjacent one of the clamping rings for blowing air through the cavities and circulating the powder. This air may serve as a carrier for additional powder.

Once the article is clamped and firmly masked the powder bed is raised so that the article is partly submerged and the stud, the clamping rings and the article are rotated with the air blowing through the cavities to circulate the powder. The powder is deposited on the unmasked parts of the article and melted and coalesced into a coating. The air blast keeps the particles in the cavities stirred up so that there is no accumulation of powder.

Next the bed is lowered and the article rotated while the air blast continues. This operation removes excess powder and solidifies the coating and reduces its tackiness. The clamping and masking ring and associated parts are then separated and the article removed. The above-described operation following the loading of the hot article on the mandrel or stud is in the practice of the specific aspects of this invention, carried out automatically on the actuation of a push button by an operator. In accordance with the broader aspects of this invention the operation may be carried out by hand.

Typically the flexible mandrel or stud may be molded from silastic rubber compounds. A suitable material is Dow RPV-501 silastic rubber which is molded with a catalyst. The stud may have dimensions corresponding to the bore diameters and the widths of the different articles to be coated. Preferably the outside diameter of the stud should be about 132 inch less than the diameter of the bore of the article.

Typically the masking and clamping rings of the peripheral masking unit may be composed of steel, aluminum and/or fluorocarbon such as polytetrafluoroethylene. Other materials such as phenolic condensation laminates may also be used. The O-rings for sealing the article within the clamping rings are preferably of 1/4-inch-diameter rubber.

The air blast to circulate the coating powder through the slots varies for different article dimensions and for different number of cavities or slots in the article. The number of nozzles through which the air flows may also vary. Typically for a shaded-pole core for a motor, which has a width of one inch and six slots, the air speed should be about 50 cubic feet per minute equally divided through two nozzles spaced 180° around the periphery of the core, so that one nozzle projects air through at least one slot immersed in the powder, and the other nozzle projects air through at least one slot not immersed in the powder. Typically, the nozzle orifice may be 3/16 inch diameter. Larger cores with substantially greater number of slots may require up to 120 cubic feet per minute air circulation divided among the nozzles. In the case of articles having small cavities such as small-slot cores it is necessary to introduce coating powder in the air circulation stream so that the end surfaces are built up by the deposit of powder from the air stream. In a typical situation the powder may be syphoned from the fluidized bed into the circulating stream.

A blast of compressed air is also necessary to fluidize the powder bed. The magnitude of this blast depends on the cross-sectional area of the powder tank and the quantity of powder being fluidized. Typically an 18-inch-diameter tank containing 75 pounds of powder requires air at 170 cubic feet per minute to fluidize. The tank may also be vibrated to help move the powder during the fluidizing. Typically the powder may be contained in a steel tank with a porous ceramic bottom plate (called diffuser plate) through which the air is circulated. The boot of the fluidized powder bed is composed of 1/16 inch thick butyl rubber or the like.

Most of the coating powders that are used in the practice of this invention particularly those typified by the above-mentioned Elbling patent are hygroscopic. In accordance with one of the aspects of this invention the air which is provided to fluidize the powder and also the air which is supplied to the nozzles which circulate the powder through the cavities is dried and freed of any foreign matter. For this purpose a dehumidifier and an oil-and-particle filter are interposed in the air line through which the air is supplied.

The speed of rotation of the article during coating is dependent on the dimensions of the article coated and the heat capacity of the article; the heat capacity governs the length of time during which the article is able to maintain the temperature at which

the powder becomes fused on the surface. Usually the larger and heavier sectioned articles may be coated in a shorter time interval than the small articles. Typically, a shaded-pole core one inch wide for a motor is rotated first in one direction and then in the opposite at the rate of about 30 rpm during the coating process and again after the bed is lowered. Larger articles of heavier section can be rotated at a higher speed but the speed should not be so high that the centrifugal forces are greater than the weight of the powder so that the powder deposits in the bottom of the cavities. Typically, the speed should not exceed 60 revolutions per minute. Reliance is placed on the heat capacity of the article, to melt and coalesce the coating powders on the surface of the article. In the case of the usual cores and the typical powders used for coating cores the temperature may be from 360° F. to 450° F. Typically, cores for motors having respectively 6, 24 and 35 slots can be coated at 420° F. with Armstrong E290 series powders. It has been found that at this temperature this coating powder yields the most uniform buildup. The atmosphere in the heating furnace in which the articles are heated must be dry and free of oily substances, foreign matter and corrosive materials.

Most powders require curing after the heating. But there are some which provide good strength characteristics as coatings when subjected only to the retained heat in the article. The cores for motors having 6, 25 and 36 slots are cured for 35 minutes at 420° F. when the coating powder is Armstrong E290 series. This is typical of the curing operation demanded.

Because of the difficulty involved in coating corners it is important that burrs on end punchings, for example produced by the blanking dyes, must be minimized. In accordance with one of the aspects of this invention substantially all of the corners are rounded off to economize on the coating powder.

The above described process and apparatus has been used successfully in coating a large number of stator cores. In practicing this process it has been discovered that the deposit of the powder on flat surfaces has about twice the thickness of the deposit on corners. In a typical situation, it has been found that the powder builds to .001 inches minimum thickness on flat surfaces while it is building up to .0055 inches minimum thickness on corners. The thickness of the coating achieved with this deposit in the practice of this invention is a .015 inch film on flat surfaces and a .0075 inch minimum corner thickness. Because of this tendency of the powder to deposit at a substantially lower rate on corners than on flat surfaces it is necessary that the flat surface deposit be approximately twice the minimum thickness necessary for corner deposits.

In accordance with a specific aspect of this invention this disadvantage is avoided by rounding off the corners of the cores in which the conductors are to be wound. To achieve this purpose the core may be molded from a magnetic powder material in molds having the proper rounded corner form. Conceivably the rounded corners may also be produced by appropriately machining the laminated cores after they are formed, by coining corners during riveting operation, and the like.

The above-described coating having a thickness of .015 inches on flat surfaces and .0075 inches on corners has substantial mechanical and dielectric strength and resistance to moderate temperatures. The impact strength is about 160 inch pounds. The material is capable of withstanding a rupture when bent to an angle of about 45°. The specific gravity of the material is between 1.20 and 1.25 and the dielectric strength of 1/1000 inch thickness is about 1000 volts.

In the practice of this invention it has been found that an important advantage of the coating is that the winding end turns can be reduced since the coating completely covers the area of the stator where the wire is wound and affords effective insulation. Because of this reduction the resistance due to losses created by end turns is reduced and the motor operates at a lower temperature than motors coated in accordance with the teachings of the prior art. This in turn results in reduction in the number of turns and/or core size.

The novel features considered characteristic of this invention are described generally above. For a better understanding of this invention both as to its organization and as to its method of operation together with additional objects and advantages thereof, reference is made to the following description taken in connection with the accompanying drawings in which:

Figure 1 is a view partly in side elevation and partly in section of coating apparatus in accordance with this invention;

Fig. 2 is a view partly in end elevation and partly in section of this apparatus;

Fig. 3 is a fragmental view, partly in section and partly in side elevation, showing the article mounting and masking mechanism of the apparatus in the loading position;

Fig. 4 is a similar view with the mounting and masking mechanism in the loaded position in which the article being coated is set for a coating operation;

Fig. 5 is a fragmental view in end elevation of the mounting and masking mechanism shown in Fig. 4;

Fig. 6 is a fragmental view taken in the direction of arrows of Fig. 5;

Fig. 7 is a view in end elevation taken in the direction of arrows VII—VII of Fig. 1 showing the intermittent (Geneva) drive included in the apparatus according to this invention;

Fig. 8 is a view in side elevation of this drive;

Fig. 9 is an asymetric view of the fluidized bed of the apparatus according to this invention;

Fig. 10 is a view in end elevation of this bed;

Fig. 11 is a view in top elevation of this bed;

Fig. 12 is a view in top elevation of the mounting or clamping and masking mechanism;

Fig. 13 is a view in side elevation of the stud cleaning mechanism included in apparatus according to this invention;

Fig. 14 is a schematic diagram of the circuit governing the automatic operation of the apparatus in accordance with this invention;

Fig. 15 is a table presenting the sequence of operation of this apparatus upon actuation of the cycle starting pushbutton;

Fig. 16 is a view in end elevation of a core in accordance with one of the specific aspects of this invention; and

Fig. 17 is a view taken along line XVII—XVII of Fig. 16.

The apparatus shown in the drawings is a complete automatic system for coating the stator cores. This apparatus includes a DRIVE, a TURRET UNIT, a FLUIDIZED POWDER BED, a CLAMPING AND MASKING UNIT, a CLEANING UNIT, and a CONTROL UNIT. A plurality of articles A to be coated may be processed simultaneously and in the apparatus actually shown two articles are processed simultaneously. For this purpose the articles are mounted on the turret 21 of the TURRET UNIT. The turret 21 constitutes a movable wall of the BED and serves to suspend the articles A in the bed and to index them out of the bed for further treatment.

The apparatus is supported on a generally rectangular box like frame work 23 formed of angles 25 enclosed in cover plates 27. A plate 29 is mounted in one section of the frame work 27 and serves to support the motor 30, the clutch 31, the brake 33 and the pulley 35 of the DRIVE. The BED is supported on a movable cradle 39 on the base of the frame work 23 and extends above the frame work where it is engaged by the turret 21.

The DRIVE includes in addition to the motor 30, the clutch 31, the brake 33, and the pulley 35, a timing belt 41 which drives an intermittent mechanism 43 such as a Geneva, through a speed reducing mechanism 45. The intermittent 43 and the speed reducer 45 are mounted on vertical plate 47 which is welded to a horizontal plate 49 secured to the frame work 23 above the motor 30 and its associated parts. The driving shaft 50 of the intermittent 43 is hollow and has a hollow hub 51 through which compressed air is supplied for various purposes to the TURRET UNIT. This air flows through a swivel joint 53 connected to the supporting plate 55 of the TURRET UNIT.

The speed reducer 45 has an eccentric 57 which operates a limit switch LS10 having two sets of contacts LS10*a* and LS10*b*, respectively (Fig. 14) at a preset angle in each revolution of the reducer. The eccentric rotates at three times the speed of the intermittent hub 51 so that the switch LS10 is operated three times during each revolution of the turret 21.

The clutch 31 and brake 33 are operated to permit the timing belt 41 to be driven at the end of each cycle when limit switches LS5, LS11, LS7, LS8 are closed (Fig. 14). Switch LS5 has two sets of contacts LS5*a* and LS5*b* respectively. When the timing belt is driven the turret 21 is advanced through one third of a revolution.

The TURRET UNIT is mounted rotatably on a vertical plate 61 which is welded to the horizontal plate 49 secured to the supporting frame work 23. This UNIT includes in addition to the turret 21 a base plate 63 having along its periphery cut-out sectors through which the driving mechanism for the CLAMPING AND MASKING UNIT may penetrate in any position of the base plate 63. The base plate 63 has secured thereto an adaptor hub 67 which is bolted to the hub 51 of the intermittent 43 and is rotatable with the hub. The hub 67 is rotatable on roller bearings 69 in an overhang 71 on the plate 61.

The upper section or container 77 of the FLUIDIZED POWDER BED is disposed adjacent the turret 21 and as the turret rotates different parts of its lower region constitute a wall of the container 77. To prevent the leakage of powder around the arm of the turret 21, the turret is provided with a felt seal 79 which cooperates with overlapping lip 81 extending from the wall section 83 of the container 77 along which the turret 21 moves (Fig. 1).

The turret carries work-supporting means 89 on which articles A are subjected to the powder in the container 77. This means 89 includes facilities for supporting two articles A at three positions spaced by about 120° around the periphery of the turret 21. Each of these facilities serve to subject the two articles A in coating receiving relationship with the powder when the turret 21 rotates so that the part of the turret on which it is mounted is in the container 77. While articles A on one supporting means 89 are

being coated, coated articles are removed from a second, and a third is being cleaned by the CLEANING UNIT to receive new articles. As is indicated in Fig. 2 the supporting means 89 at different positions on the turret 21 may be regarded as at three stations; a Loading Station, an Unloading Station (where processed articles are removed) and a Cleaning Station.

Each work-supporting means 89 is in effect a pair of parts of the CLAMPING AND MASKING UNIT which may be described as stud-ring units of the CLAMPING and MASKING UNIT. Each stud-ring unit includes a stud or mandrel 91 of a flexible material such as rubber or the like. One end of the stud 91 is abutted by a washer 93 which has flexible arms 95 suspending a ring 97 adapted to engage the periphery of the article A. The inner periphery of the ring 97 has an O-ring 99. The rim of the ring 97 is partly beveled and grooved and carries another O-ring 101 in the groove. Each stud-ring unit 91—97 is mounted on a hollow shaft 103 (Fig. 3) which is rotatable in a roller bearing 105 in the turret 21 and abuts against ball bearing 106 in the base plate 63 which serves as a thrust bearing for the shaft 103 and is sealed by a seal 108. The bearing 105 is provided with a felt seal 107 to prevent the penetration of powder into the bearing. Each hollow shaft 103 carries a pulley wheel 109.

The pulley wheels 109 at the loading and cleaning stations are engaged by a belt 111 so as to rotate the shaft 103 and associated stud-ring unit 91—97. This belt 111 is rotated by a rack 113 and pinion 115 moved by a piston rod 117 on a piston in cylinder 119. The cylinder 119 is mounted on the vertical base plate 61 and the rack 113 is movably connected to its piston rod 117. On the shaft of the pinion 115 a pulley wheel 121 engaging the belt 111 is provided. The rack includes a dog 122 which at each extreme position of the rack 113 operates a limit switch LS3 and LS4, respectively.

A bracket or lever 123 is mounted pivotal about the shaft of the pinion 115 and pulley wheel 121. This bracket 123 carries an idler pulley wheel 125 at one end. The idler pulley wheel 125 is resiliently held in engagement with the belt 111 by a spring 127 secured to the base plate and to the opposite end of the bracket 123. The pulley wheel 125 also serves to separate the belt 111 from the pulley wheels 109 at the unloading station. In the operation of the apparatus the rack 113 is repeatedly moved forwardly and backwardly to rotate the articles A on the studs 91 at the loading station and the stud-ring unit 91—97 at the Cleaning Station while the coated articles A are removed from the studs 91 at the Unloading Station.

The studs are expanded by compressed-air actuated cylinder 139. The expansion is effected by compressing the stud 91 between the washer 93 and a washer 151 abutting the opposite end of the stud 91. The flexible arms 95 aid in the compression and relocation of the stud between the washers 93 and 151. The washer 151 is connected to a shaft 153 which extends through the hollow shaft 103 and terminates in a thrust bearing 159 which is secured in a bend at each end of the cross bar 145. At its center the cross bar 145 is connected to a piston-rod 161 from the cylinder 139. The piston rod 161 counteracts springs 163 which maintain the washer 151 outwardly from the stud and the stud unexpanded. When the rod 161 is moved it urges the washer 151 inwardly and expands the stud causing it to engage firmly the bore of the article A being coated. The shaft 153 is rotatable with shaft 103 but slidable therein.

The turret also carries a plurality of valves 131, each valve being associated with a pair of the stud-ring units 91—97. Each valve has an air inlet 133 connected to the outlet 135 from the swivel joint 53 and an air outlet 137 connected to the stud expanding cylinder 139 of the associated CLAMPING AND MASKING UNIT. Each valve 131 is maintained normally open permitting air to flow to the associated cylinder 139, and each valve is provided with a closing mechanism actuable by the pivoting of a cam follower 141. A cam 143 is provided on the support 61 at the Unloading Station. When a pair of stud-ring units 91—97 reach this Unloading Station the cam 143 cooperates with the cam follower 141 to close the associated valve 131 and prevent the flow of air into the associated cylinder 139. This prevents the associated cross bar 145 from expanding the studs 91 in the Unloading Station so as to permit unloading of the coated articles.

The CLAMPING AND MASKING UNIT includes, in addition to the stud-ring unit 91—97 and the shafts 103 and 153 and other parts described, clamping rings 171 cooperative with each stud-ring unit 91—97 at the Loading Station. A bearing shell 173 is suspended from a plurality of resilient arms 175 extending from each ring 171. Each ring 171 and shell 173 are rotatable in a bearing 177 within the shell. Each ring 171 carries an O-ring 179 in its inner periphery and has a beveled rim which firmly engages the O-ring 101 when the ring 171 is in clamping position.

Each bearing 177 and ring 171 are suspended from a horizontally slidable shaft 181 which terminates in a cup-shaped stud 183 on which the fixed race 185 of the bearing 177 is supported. Each shaft 181 is slidably supported in bearings 189 mounted on a horizontal plate or table 191 which is mounted

on another plate 193 secured to the framework 23 (Figs. 1 and 12). Each shaft 181 carries a dog 195 and 197 respectively. Dog 195 actuates limit switch LS6 when the shaft 181 is in the clamping position and dog 197 actuates limit switch LS7 when the shaft 181 is in the retracted position.

Each shaft 181 has a longitudinal opening 201 which communicates at one end with a radial opening 203 connected to an air supply (not shown) and at the other end with radial openings 205 in the stud 183. A pair of nozzles 207 are mounted in the lateral openings 205 in the stud 183. Gas is supplied through the axial opening 201 in the shaft 181 and through the lateral openings 205 and the nozzles 207 to the cavities of the article A being coated.

The shafts for both rings 171 at the Loading Station are actuable by a piston rod 211 in a cylinder 213 which actuates a cross bar 215. This cross bar is forked at its ends and the head of each shaft 181 is connected to a corresponding forked portion by a dowel pin 217. When the cross bar 215 is moved by the piston rod in the outward direction it carries the slidable shaft outwardly moving the clamping rings 171 outwardly and when the cross bar is moved inwardly the ring 171 is engaged with the ring 97. When the shaft 181 is moved inwardly the O-ring 101 is compressed by the beveled edge of the ring 171 and the joint between the rings 97 and 171 is sealed. The article A is disposed on the flexible stud 91 in a position so that at the edges of its periphery it engages the O-rings 99 and 179. The inner periphery of the rings 97 and 171 are dimensioned so that the article to be coated fits snugly into the O-rings. When the stud is expanded or bulged outwardly the inner bore and the outer periphery of the article are sealed by the stud 91 and by the O-rings 97, 101 and 179, respectively.

The ring 97 is rotatable when the pulley wheel 109 is rotated by the belt 111. This ring 97 being in engagement with the ring 171 causes the latter to rotate on the bearing 177. The nozzles 207 being connected to the fixed race 185 are not rotatable and thus effectively project air into the cavities of the article A to maintain the powder in the cavities in motion and prevent the deposit of excessive powder in the cavities.

In the operation of the apparatus, the turret 21 is indexed about 120° at the end of each cycle. This indexing advances the stud ring units 91—97 on which coated articles A are mounted to the Unloading Station, advances the stud ring units which had been at the Unloading Station to the Cleaning Station and advances the stud ring units which had been at the Cleaning Station position to the Loading Station. The articles are unloaded in the Unloading Station and the apparatus carries out another operation.

The CLEANING UNIT is mounted adjacent the Cleaning Station and includes a pair of rods or shafts 221 (Fig. 13) slidable in bearings 223 supported on the base plate 61. The rods 221 carry a plate or bracket 225 on which a pair of motors 227 are mounted. On the shaft 229 of each motor a wire tube brush 231 is mounted; this brush has peripheral bristles 233 for cleaning the surface of a stud 91 and end bristles 235 for cleaning the adjacent ring 97 of an associated ring-stud unit. The shafts 221 and bracket 225 are connected to a piston rod 237 (Fig. 2) of an air cylinder 239 and are slidable by the rod 237 in a direction transverse to the axis of the turret 21. In the outermost position, the brushes 233 are displaced from the position adjacent the stud-ring units 91—97 permitting these units to be indexed to the Cleaning Station. In the innermost position, the brushes 233 are in engagement with the studs 91 and the O-rings 101. After the CLEANING UNIT is in the innermost position the motors 227 are energized rotating the brushes 233 to clean the studs 91 and also with their ends to clean the inner peripheral surfaces of the associated rings. In the retracted position the plate 225 operates limit switch LS8 to the closed position.

The FLUIDIZED POWDER BED includes a lower section 241 containing the powder 243 and an upper section 245 in which the article A is subjected to the powder on the CLAMPING AND MASKING UNIT. These sections are joined by a flexible boot 247. The lower section 241 includes a cylindrical tank 251 resiliently suspended by springs 253 from a generally square shell 255. The base of the cylindrical tank 251 is a porous block 257. The porous block 257 is encapsulated and the fluidizing air is transmitted through the encapsulation 259 and through the block 257 into the powder 243 which is disposed on the block through a tube 261. To improve the fluidizing of the powder 243 the tank 251 is vibrated by an air motor 263 connected to the encapsulation 259. The shell 255 is mounted on the cradle 39 which is vertically movable to raise or lower the tank 251 and the level of the powder from the lower level 267 to the operation level 269 by operation of an air cylinder 271. When the cylinder 271 raises the tank 251 to the operating position limit switch LS1 is closed.

The upper section 245 is a housing of sheet metal extending from a cylindrical stem 283 and having a gabled roof 285. The sheet metal forms one end wall 287, the side walls 289 and 290 and the roof 285. The other end wall is formed by the part of the turret 21 which overlaps the housing and

is sealed by the felt rim 79 and the angular overlap 81 (Fig. 1). One of the sides 291 of the roof 289 includes a loading gate 293 which when opened permits loading of the articles A on the stud-ring units 91—97 and the other side 295 includes an entrance gate 297 through which the cleaned stud-ring units 91—97 are moved into the Loading Station.

The gates 293 and 297 are operated by air cylinders 299 and 301, respectively. On the opening of the loading gate 293 limit switch LS11 is closed and on the opening of the entrance gate 297 limit switch contacts LS5a and LS5b are closed. One side 290 also includes a tubulation 303 through which the cloud of powder generated during the fluidized operation is exhausted. This powder may be collected and replaced in the BED. A collection nozzle (not shown) is also provided under the Cleaning Station to exhaust cleanings during this operation.

The boot 247 permits the level 267 of the powder to be raised to the operating position. The level is raised from the lower position 267 well below the upper section 245 to an upper position 269 in which the articles A to be coated are partly (typically to the center of the core) immersed in the powder (see Fig. 2).

The standby condition and the operation of the apparatus can be understood from a consideration of Figs. 14 and 15. In Fig. 14 the schematic diagram of the apparatus is shown and in Fig. 15 the operation is sequentially tabulated. The apparatus may be operated both manually and automatically and is provided with pushbuttons SCA for setting the operation. In the following discussion only the automatic operation will be considered. The various components of the apparatus are operated by pistons in cylinders. The flow of fluid to the cylinders is controlled by solenoids shown in the diagram.

The apparatus is energized from polyphase buses L1, L2, L3 which supply single phase power for control purposes to conductors AL1 and AL2 through transformer T. The apparatus includes start and stop pushbuttons ST1 and SP1 for the apparatus as a whole and like buttons ST2 and SP2 for the motors 227 of the CLEANING UNIT. The apparatus also includes a manually actuable push button CST for starting a cycle of operation. In addition there is a main contactor M1 and an auxiliary contactor CRM. There are also relays CR1, CR2, CR3 and CR4 and a sequence controller SC which has cam operated switch mechanisms labelled SC1 through SC16. The sequence controller SC is provided with a solenoid SCR which on each actuation advances the controller one position.

In the table of Fig. 15 the column on the left labelled "POSITION" presents from top to bottom the sequential actuating of the mechanism of the apparatus for one complete operation of the apparatus. The other columns are labelled by the identification of the switches of the controller SC. In addition these columns are headed by identifications of the various operations which take place. A circle in a block in a column means that the switch contact at the head of the column is closed in the step heading the rows of the block. From a consideration of Fig. 15 the sequence of operation of the diagram in Fig. 14 can be understood.

To set the apparatus for standby the start push-buttons ST1 and ST2 are closed. Contactors M1 and CRM are actuated and locked in through contact M1a. At contacts M1b, M1c, M1d main drive motor 30 is energized. This drive motor rotates but the timing belt 41 is not actuated because the clutch 31 is disconnected and the brake 33 is in the braking position. In addition, relay CR3 is actuated and locked in through contact CR3a. The motors 227 connected to the cleaning brushes 231 are energized.

During standby the sequence controller SC is in start position (second row, Fig. 15). In this position contacts SC5, SC9, SC14 are closed. Relay CR1 is energized and locked in through CR1a. CR1b is closed conditioning the clamping solenoid SOC to be energized when the cycle push-button CST is closed. SOC also controls the loading gate 293 and closes this gate when it is energized. At SC9 the solenoid SOE is energized to close the entrance gate 297; at SC5 the solenoid 311 of the controller SC is conditioned to be energized on the closing of LS6.

In the standby condition of the apparatus the loading gate 293 is open and the movable masking rings 171 and the expanding washers 151 on the studs 91 are in the retracted positions. During standby the blow-off air is supplied continuously through the center of the shaft on which the movable masking ring 171 is mounted and through the nozzles 207 connected to this shaft. (This air may be blocked by a valve during standby).

To start the operation, the operator loads the articles A which have been heated to the melting temperature of the powder with prongs onto the studs 91 at the Loading Station. Once these studs are loaded the operator presses the cycle pushbutton CST. On actuation of the cycle push-button the solenoid SOC is energized through contacts CSTa and through now closed front contacts CR1b. This actuates the shafts 181 carrying the movable masking rings 171 to move inwardly and engage the ring 97 on the stud-ring unit 91—97 to seal the periphery of the articles A. This solenoid SOC also closes the loading gate 293.

The movement of one of the shafts 181

closes limit switch LS6. The closing of limit switch LS6 energizes the controller solenoid SCR through the closed switch SC5 and the back contact SCAa of the automatic-manual button SCA and through a back contact SCR*a* of the solenoid SCR. This causes the sequence controller to advance to the second position (Fig. 15) in which the switches SC1, SC2, SC6, SC9, SC11, SC14 and SC16 are closed and SC5 is opened. The closing of switch SC1 locks in the solenoid SOC, the closing of SC11 energizes solenoid SOX which actuates the shafts 103 carrying the washers 151 on the studs 91 expanding the studs to engage the bores of the articles A. Through SC2 the solenoid SOB which controls the cradle 39 is energized raising the powder to level 269, the coating position, so that the article is partly immersed in the powder. The closing of SC6 conditions the sequence-controller solenoid SCR to be actuated through limit switch LS1. The closing of SC16 conditions the apparatus to be reset through contact SCAb.

When the powder is at level 269 switch LS1 is closed producing another actuation of the sequence controller to the third position. In this position the switches SC1, SC2, SC3, SC4, SC9, SC11, SC12, SC14 and SC16 are closed and SC6 is opened. The closing of switch SC3 energizes the rack solenoid SOR to be energized and the articles A and their mounts to be rotated in the counterclockwise direction through the rack 113 and pinion 115. The closing of contact SC4 actuates a solenoid SOS to cause the brushes 231 to engage the studs 91 and the rings 97 of the stud-ring units at the Cleaning Station and these components are cleaned. The closure of switch SC12 conditions solenoid SCR to be actuated through limit switch LS3.

At the end of the counterclockwise rotation the rack engages limit switch LS3 actuating the sequence controller SC to position 4. This position is the same as 3 except that SC3 and SC12 are open and SC10 closed. With SC3 open SOR is deenergized and the rack 113 returns to its initial position. LS3 is reopened. The closing of switch SC10 conditions the sequence controller to be actuated on the reclosing of limit switch LS4 which is now open. On the return of the rack the articles A are rotated in the clockwise direction. On the completion of this rotation the rack 113 returns to its lowermost position closing contact LS4 and actuating the sequence controller SC to move to position 5. This position is the same as 4 except that SC2 and SC10 are open and SC3 and SC12 are reclosed. The opening of SC2 deenergizes the solenoid SOB and the powder is returned to its lowermost level 267. The closing of switch SC3 again actuates the rack 113 rotating the articles A in the counterclockwise direction. SC12 again conditions SC to be actuated through LS3. When the rack 113 reaches its uppermost position again LS3 is reclosed actuating SC to the position 6. This position is the same as 5 except that switches SC3, 4 and 12 are open and switch 10 is reclosed. On the opening of switch SC4, the cleaning brushes 231 are removed from the associated studs 91 and rings 97 and on the opening of SC3 the rack 113 returns to its initial position rotating the article and the rings in the clockwise direction to provide additional cleaning as the brushes 231 are retracted. The reclosing of SC10 reconditions the solenoid SCR to be again actuated on the closing of LS4.

When the rack 113 reaches its lowermost position LS4 is closed causing SC to be advanced to position 7. In this position switches SC1, SC9, SC10 and SC14 are opened, and switch SC7 is closed. The closing of SC7 conditions the sequence controller to be actuated on the closing of limit switch contact LS5a. When SC1 is opened the solenoid SOC controlling the loading gate 293 and the movement of the movable masking rings 171 are deenergized so that the loading gate 293 opens and the masking rings 171 return to the retracted or loading position. On the opening of SC9, the solenoid SOE which controls the entrance gate 297 is opened permitted new stud-ring unit 91—97 to be moved from the Cleaning Station to the Loading Station. The opening of SC10 resets the apparatus for another operation. The opening of SC14 deenergizes relay CR1 and prevents reoperation of the apparatus until the operator releases and recloses the cycle button CST. This is a so-called non-beat feature and precludes against a cycle with an unloaded CLAMPING AND MASKING UNIT.

The opening of the entrance gate 297 closes LS5a actuating the sequence controller to position 8, and also closes LS5b. In position 8, SC7 is open and SC8 and 13 are closed. SC13 is in circuit with LS10*a* and relay CR4. The intermittent 43 stops during each cycle with LS10a open and LS10b closed. SC13 then conditions CR4 to be closed on the closing of LS10a.

With the entrance gate 297 in full open position, the cleaning brushes 231 in the full retracted position, and the loading gate 293 in the full open position, LS5b, LS8, LS7 and LS11 are closed so that power is supplied to the rectifier 313 which controls relay CR2, the clutch 31 and the brake 33. When SC8 closes CR2 is energized. CR2a and CR2b close to actuate the clutch solenoid 31 and CR2c and CR2d open to deenergize the brake solenoid. The clutch then engages advancing the timing belt 41 and in turn causing the turret to rotate through approximately 120°. LS10a closes and LS10b opens.

Relay CR4 is energized and locked in through CR4a. Contact CR4b closes conditioning SC to receive another actuation on the reopening of LS10a and the reclosing of LS10b after the indexing is complete. The actuation of the sequence controller SC sets it in position 1 opening SC8, 11, 13 and 16 and closing SC5, 9, and 14. The opening of contacts SC8, 11, 13 and 16 stops belt 41 and resets the apparatus for another operation. The closing of contact SC5 conditions the sequence controller solenoid 311 to be actuated to position 2 on the closing of LS6; the closing of SC9 closes the entrance gate 297. The closing of SC14 conditions relay CR1 to be actuated by the cycle pushbutton CST to start another operation.

In practice the apparatus disclosed herein has been used to coat stators at the rate of about 4 per minute or 240 per hour. In situations in which it is necessary to cure the coating the articles are removed on being unloaded are conveyed to the heating oven for curing.

The modification of this invention shown in Figs. 16 and 17 is a core 321 of a dynamo-electric machine in which the corners 323 on which the conductor 325 is wound are rounded off. With properly rounded corners the deposit of the fluidized powder may be substantially or nearly at the same rate on the corners as on the flat surfaces and a considerable saving in the powder deposited may be achieved. In addition the dielectric strength at the corners as well as the electrical cut-through strength is increased.

While preferred embodiments of this invention have been disclosed herein many modifications thereof are feasible.

WHAT WE CLAIM IS:—

1. A method of applying material in the form of fluidized powder to an article having at least one slot, cavity or the like in order to provide a coating of the material on at least a wall surface of the said at least one slot, cavity or the like, comprising partially immersing the article in the fluidized powder with said at least one slot, cavity or the like extending in a horizontal direction, rotating the article about a horizontal axis while it is so partially immersed, the immersion and the rotation being such that the surface or surfaces to be coated are accessible to the powder, and circulating the powder through the said at least one slot, cavity or the like by means of at least one gas blast while the article is so rotated and immersed.

2. A method as claimed in claim 1, and comprising masking the surface or surfaces of the article that are not to be coated before the article is partially immersed in the powder.

3. A method as claimed in claim 1 or 2, and comprising heating the article before it is partially immersed to at least a temperature at which the powder melts, and rotating the article while it is at or above that temperature.

4. A method as claimed in any one of claims 1 to 3, wherein the said article is rotated alternately in opposite directions at least during the partial immersion in the powder.

5. A method as claimed in any one of claims 1 to 4, wherein the powder is circulated by blowing with gas.

6. A method as claimed in claim 5, wherein the powder is circulated by blowing with air.

7. A method as claimed in any one of claims 1 to 6, wherein the fluidized powder is in the form of a bed in which the article is partially immersed, and additional powder is circulated with the powder of the bed.

8. A method as claimed in claims 5 and 7, wherein the said additional powder is circulated by blowing with a stream of gas carrying the additional powder.

9. A method as claimed in claim 5, wherein the powder is circulated by at least one gas jet projecting gas through the portion of the said at least one slot, cavity or the like immersed in the powder, and there is provided at least one other jet projecting gas through the portion of the said at least one slot, cavity or the like not immersed in the powder.

10. A method as claimed in any one of claims 1 to 9, and comprising separating the article from the powder subsequent to the said immersion and rotation, and thereafter blowing gas on the article to solidify the powder coating thereon.

11. A method as claimed in any one of claims 1 to 10, and comprising disposing the article above the level of the fluidized powder, raising the level of the powder to partially immerse the article therein, and subsequent to the immersion and the rotation in the powder lowering the level of the powder to remove the article therefrom.

12. A method as claimed in claim 11, and including rotating the article after it has been removed from the powder to remove excess powder therefrom.

13. A method as claimed in any one of claims 1 to 12, wherein the said article is a hollow cylindrical motor stator having winding slots therein.

14. A method as claimed in claim 13, wherein the stator is rotated about its longitudinal axis.

15. A method as claimed in claim 13 or 14, wherein substantially all corners of the stator on which a conductor is to be wound are rounded off.

16. A method substantially as hereinbefore described with reference to the accompanying diagrammatic drawings.

17. Apparatus for applying material in the

form of fluidized powder to an article having at least one slot, cavity or the like in order to provide a coating of the material on at least a wall surface of the said at least one slot, cavity or the like, comprising means for partially immersing the article in the fluidized powder, means for rotating the article at least while it is so partially immersed, the immersion and the rotation being such that the surface or surfaces to be coated are accessible to the powder, and means for circulating the powder through the said at least one slot, cavity or the like while the article is so rotated partially immersed.

18. Apparatus as claimed in claim 17, wherein the means for circulating the powder comprises at least one gas jet directing a stream of gas into the immersed portion of the said at least one slot, cavity or the like.

19. Apparatus as claimed in claim 18, wherein there is provided at least one other gas jet projecting a stream of gas into the unimmersed portion of the said at least one slot, cavity or the like.

20. Apparatus as claimed in any one of claims 17 to 19, wherein the fluidized powder is in the form of a bed in which the article is partially immersed, and there are provided means for circulating additional powder with the powder of the bed.

21. Apparatus as claimed in claims 18 and 20, wherein the means for circulating the additional powder comprises a stream of gas in which the powder is entrained.

22. Apparatus as claimed in claim 19, wherein the said at least one other gas jet provides gas for solidifying the powder coating after the article is removed from the powder.

23. Apparatus as claimed in any one of claims 17 to 22, wherein the said means for rotating the article rotate it alternately in opposite directions at least while immersed in the powder.

24. Apparatus as claimed in any one of claims 17 to 23, wherein the said means for rotating the article rotate it after its removal from the powder to remove excess powder therefrom.

25. Apparatus as claimed in any one of claims 17 to 24, wherein before immersion in the powder the article is mounted above the level thereof, and there are provided means for raising the level of the powder to partially immerse the article therein, and for lowering the level of the powder subsequent to the immersion and the rotation in the powder to remove the article from the powder.

26. Apparatus as claimed in claim 25, wherein means for containing the fluidized powder comprise a tank including an upper section in which the article is positioned, a lower section, and an intermediate flexible section joining said upper and lower sections and permitting raising of the said lower section toward the upper section, and means for raising and lowering the level of the powder comprise means for raising and lowering the lower section relative to the upper section.

27. Apparatus as claimed in claim 26, wherein the said raising means are responsive to the positioning of the article in the upper section to raise the level of the powder in the container so that the powder is in coating relationship with the positioned article.

28. Apparatus as claimed in claim 27, wherein the means for rotating the article are operative upon the setting of the powder level for coating relationship to rotate the article, the said raising means are operative upon completion of the rotation of the article to drop the powder level below coating relationship, and the rotating means are operative upon the dropping of the level to rotate the said article to remove excess powder therefrom.

29. Apparatus as claimed in any one of claims 17 to 28, wherein means for mounting the said article during immersion and rotation in the powder are coated by the powder, and there are provided means for cleaning deposited powder from the mounting means after the coated article has been removed therefrom.

30. Apparatus as claimed in any one of claims 17 to 29, and comprising a container enclosing said powder, the container having openable and closable openings for the admission of an article to the interior thereof and its withdrawal therefrom, and having at least a part of one wall formed by a movable member, the apparatus also comprising means for opening and closing the said openings in timed relation with the movement of the movable member, work supporting means mounted on a part of the said movable member for mounting an article to be coated, and means for moving the movable member relative to the container for conveying an article into and out of the container interior in the coating of the article.

31. Apparatus as claimed in any one of claims 17 to 30, and comprising mounting means for mounting an article to be coated, means connected to the mounting means for moving the latter and an article mounted thereby into coating relationship with the powder, clamping means co-operative with the mounting means to clamp the article on the mounting means, and means responsive to the movement of the mounting means into the said coating relationship for actuating the said clamping means to clamp the article.

32. Apparatus as claimed in any one of claims 17 to 31, wherein means for mounting the article for rotation also comprise

means for masking a portion or portions of the article that are not to be coated.

33. Apparatus as claimed in claim 32, wherein the said article is a hollow cylindrical article and the said mounting means comprise a mandrel of compressible material insertable within the inner periphery of the article, and means for compressing the mandrel axially of the article so that it firmly engages the said inner periphery.

34. Apparatus as claimed in claim 32, wherein the said article is a hollow cylindrical article and the said mounting means comprise a rotatably supported mandrel on which said article is to be mounted with said inner periphery contiguous to said mandrel, a first and second rotatably supported rings encircling said mandrel, the inner diameter of both said rings being such that when said article is mounted on said mandrel its outer periphery is adjacent the inner periphery of said rings, and means for moving one of said rings axially from a position in which said second ring is remote from said first ring to permit mounting of said article on said mandrel, to a position in which the face-to-face peripheral faces of said first and second rings are in engagement, said mandrel masking the inner periphery of said article and said rings masking the outer periphery of said article.

35. Apparatus as claimed in claim 34, wherein there are provided sealing means interposed between the face-to-face peripheral faces of the rings.

35. Apparatus as claimed in claim 34 or 35, wherein the said mandrel is of compressible material, each of said rings includes sealing means within its inner periphery, and there are provided means actuable by said moving means when said moving means has moved said rings into engagement with one another for actuating said mandrel to resiliently seal the inner periphery of said article and to urge the outer periphery of said article into resilient sealing engagement with the last-mentioned sealing means.

37. Apparatus as claimed in any of the claims 17 to 36, substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

38. Apparatus for coating electric motor stator cores, substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

39. Apparatus for carrying out the method as claimed in any of the claims 1 to 16, substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

CRUIKSHANK & FAIRWEATHER,
Chartered Patent Agents,
Suite 158, Temple Chambers,
Temple Avenue, London, E.C.4, and
29 St. Vincent Place, Glasgow,
Agents for the Applicants.

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1001030 COMPLETE SPECIFICATION

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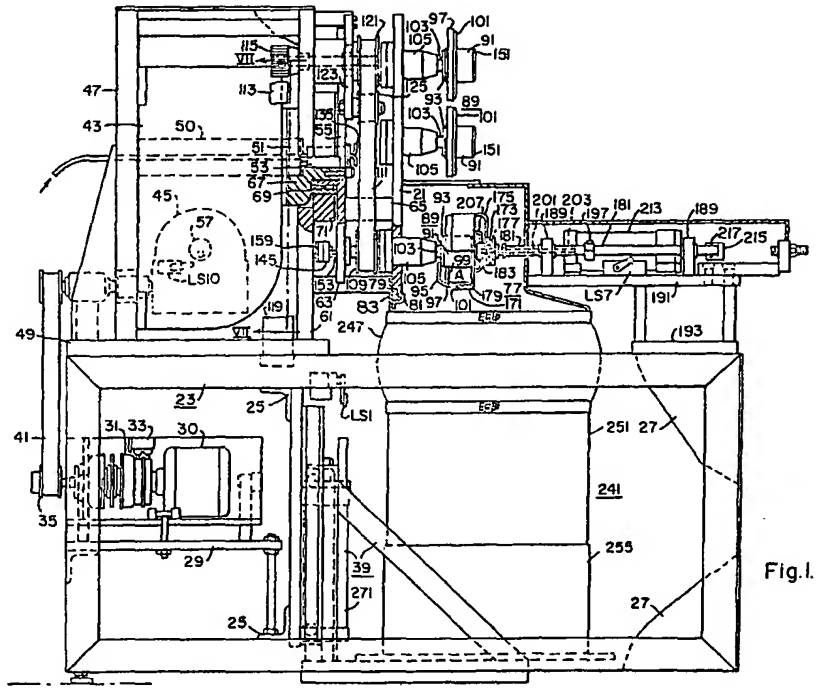
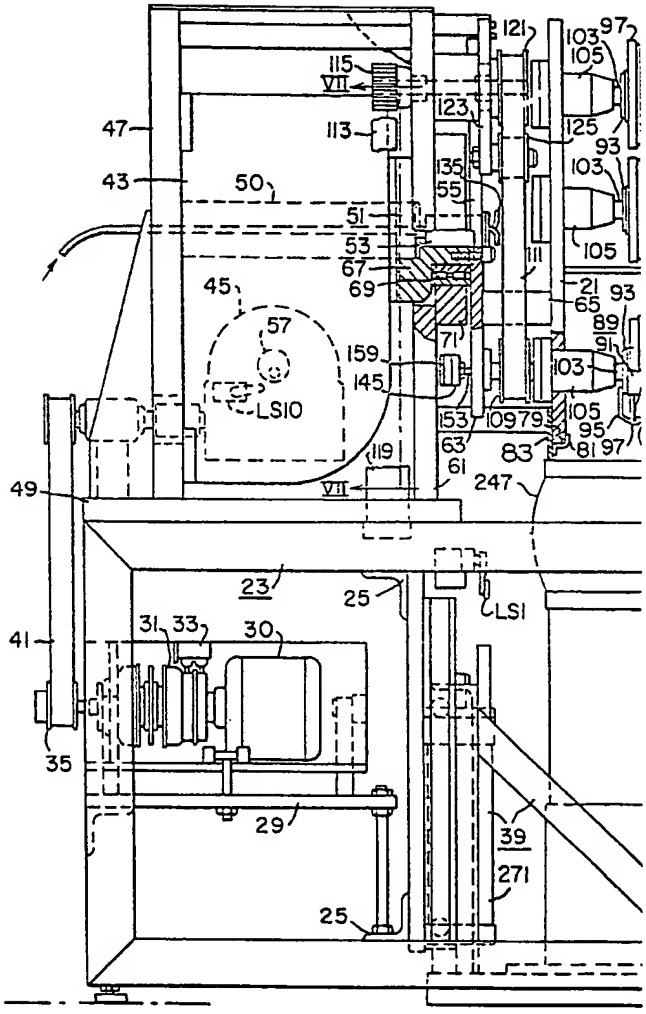


Fig.1.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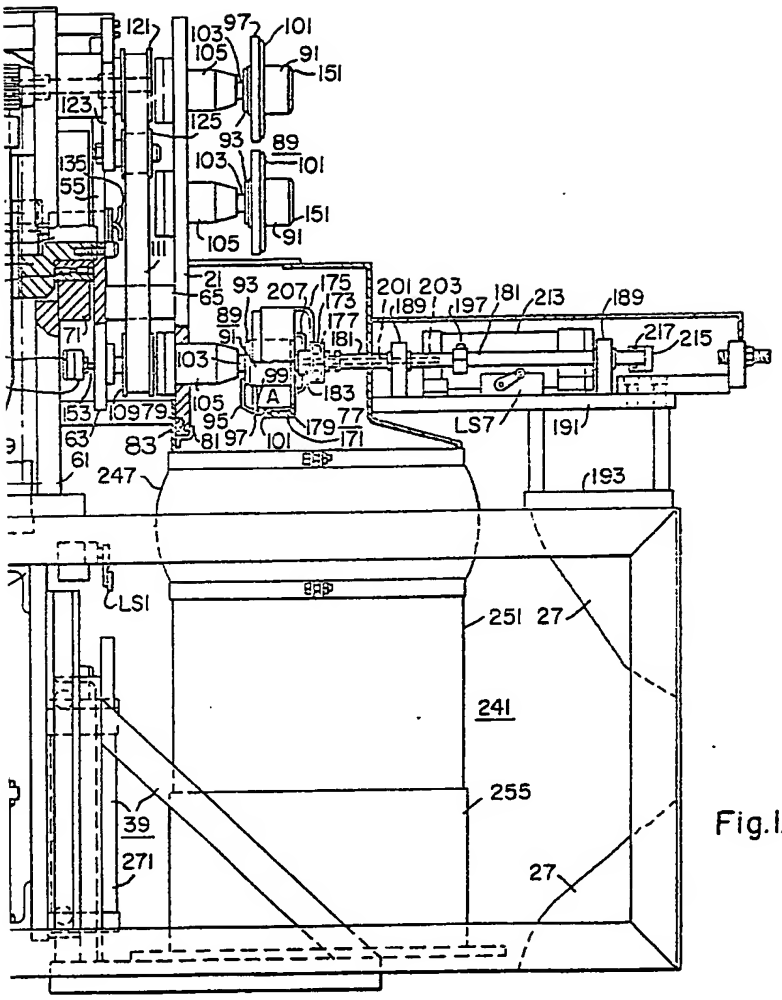

Fig.1.

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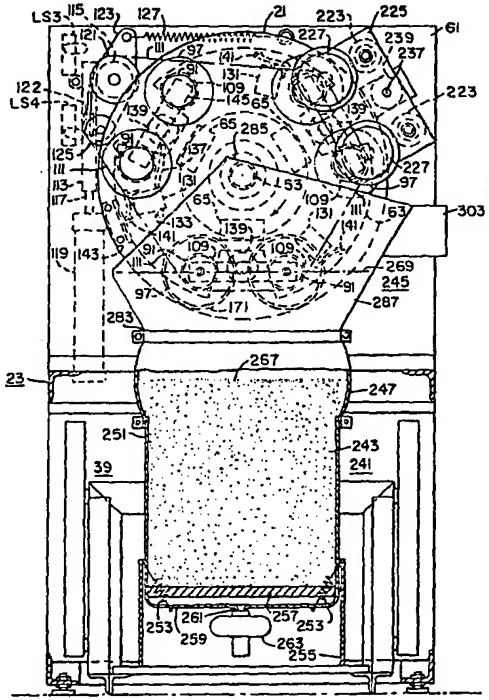
Fig.2.



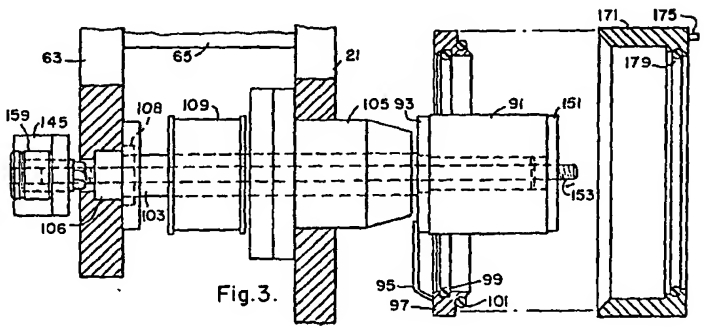


Fig.3.

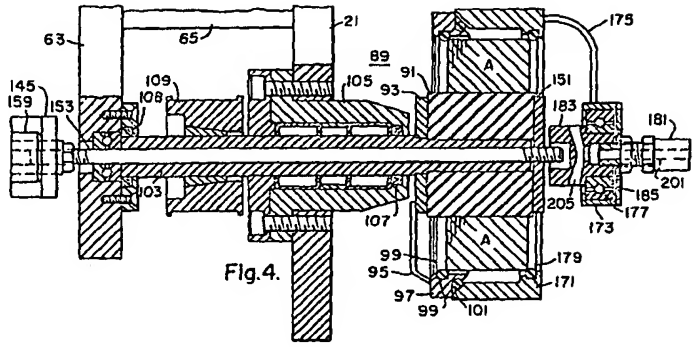
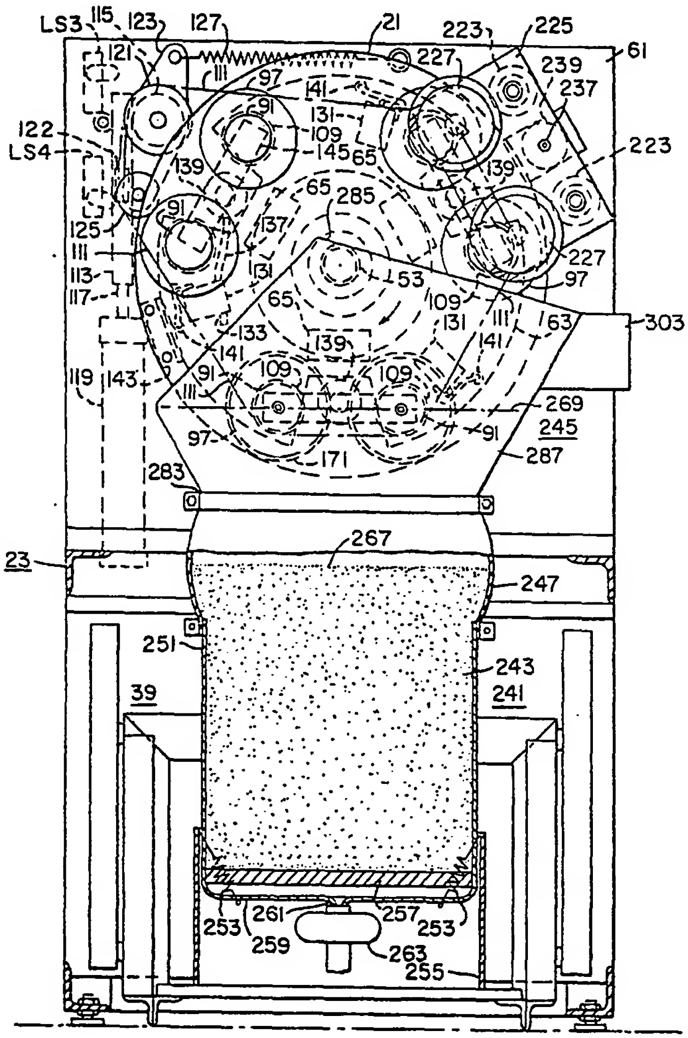


Fig.4.

Fig.2.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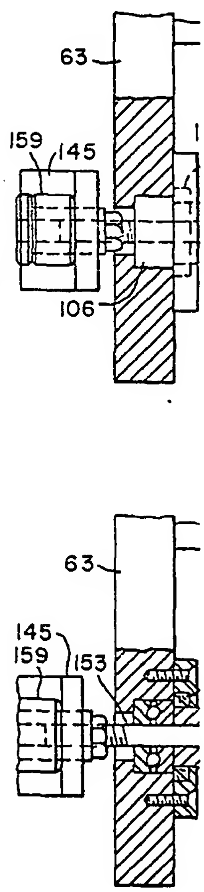
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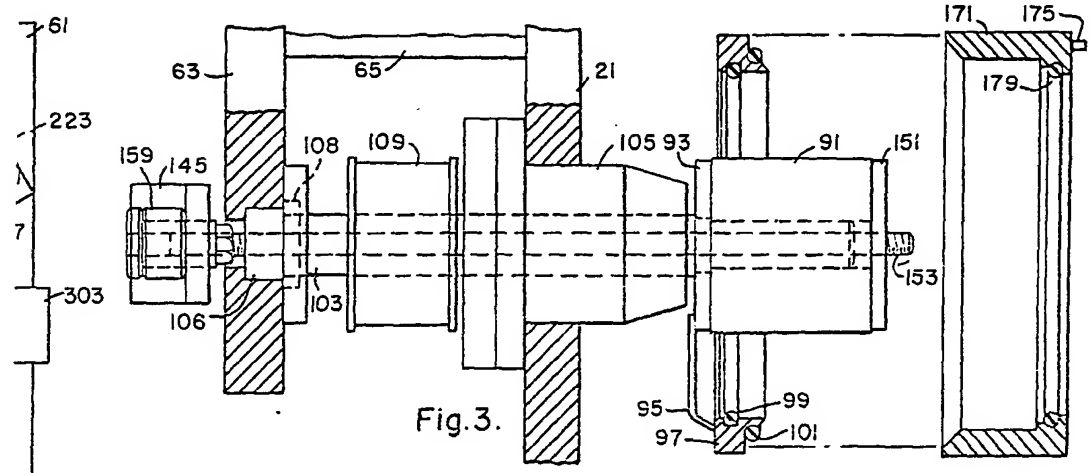

Fig.3.

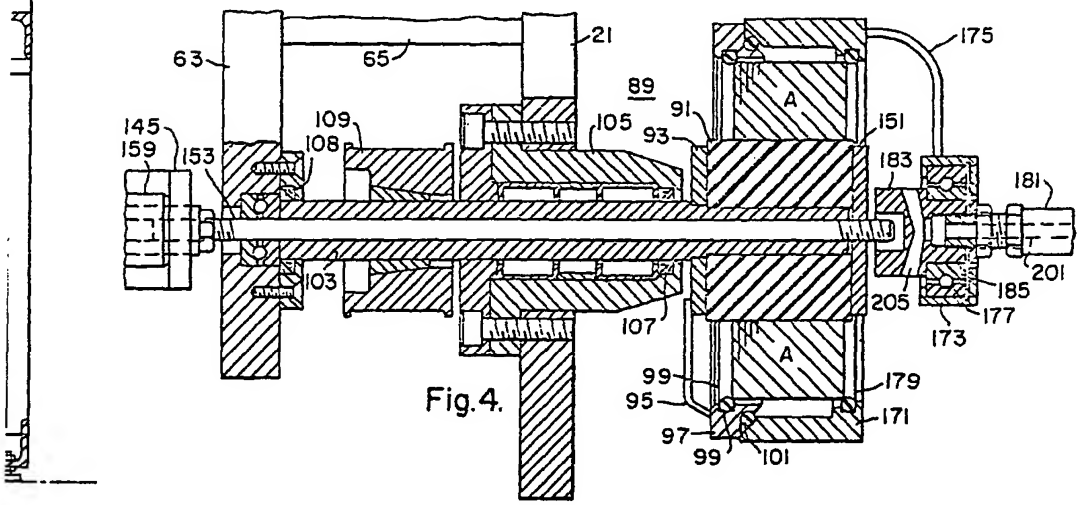

Fig.4.

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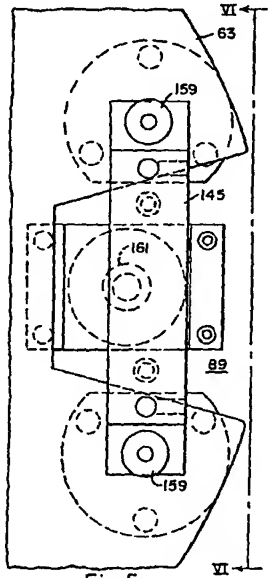

Fig.5.

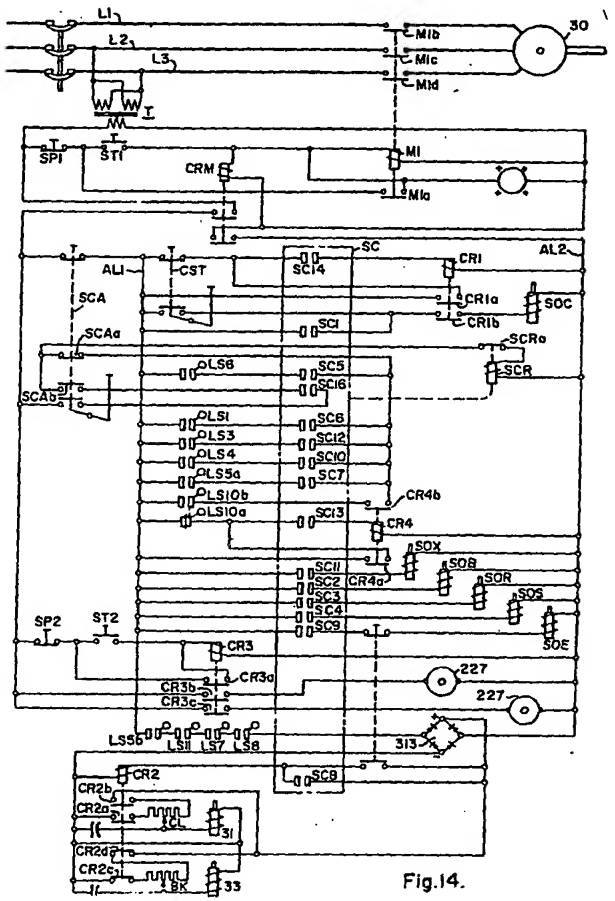

Fig.14.

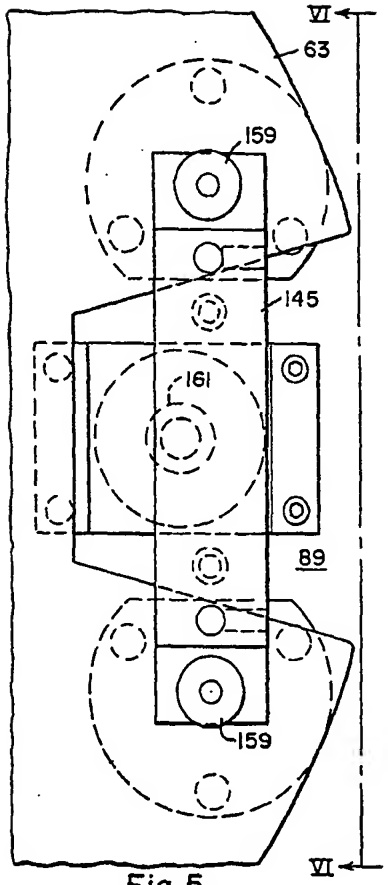
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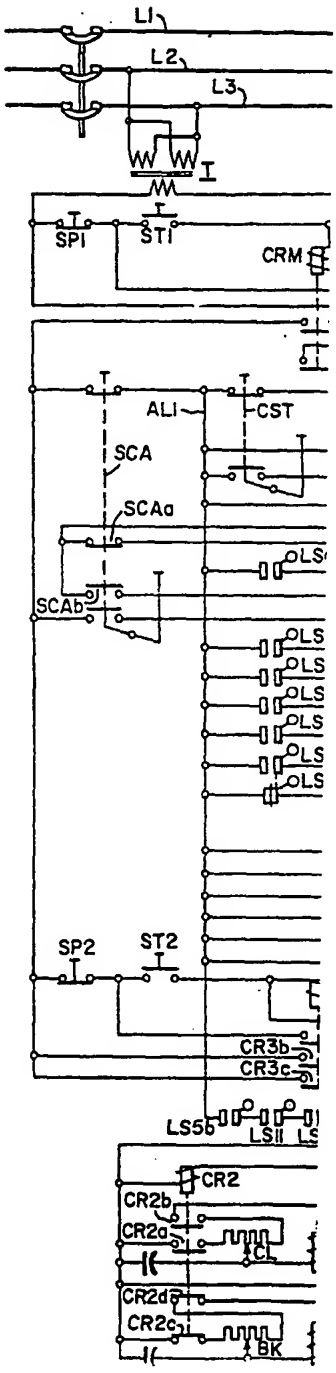
Fig. 5.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CR2c
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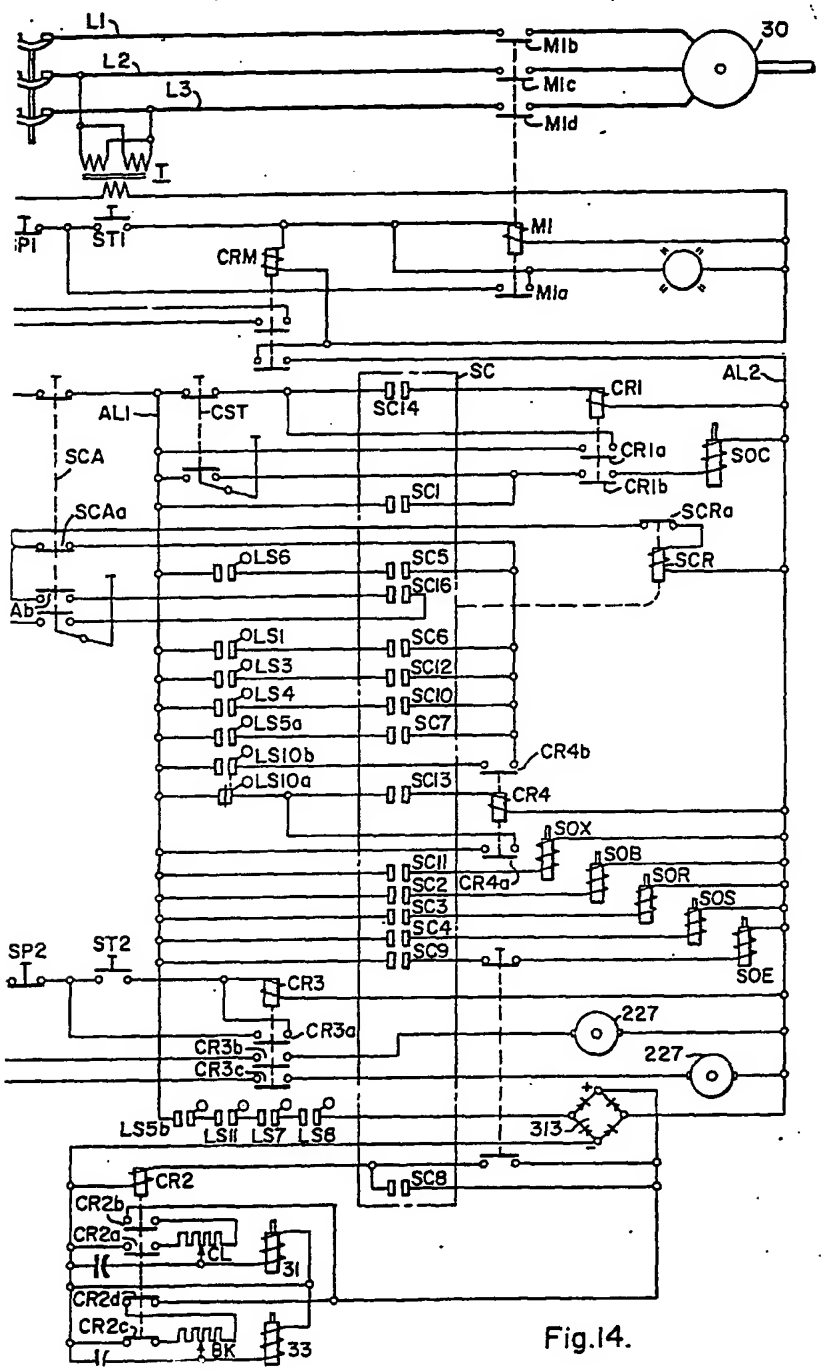

Fig.14.

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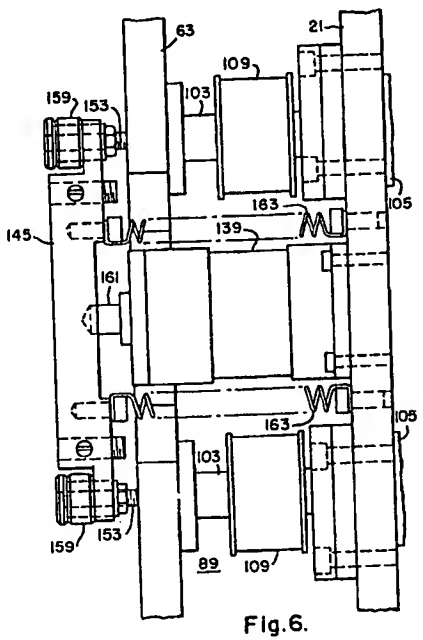


Fig.6.

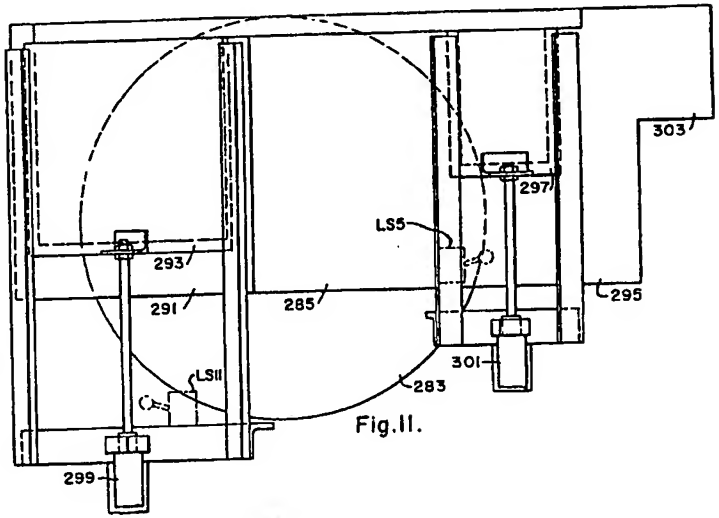
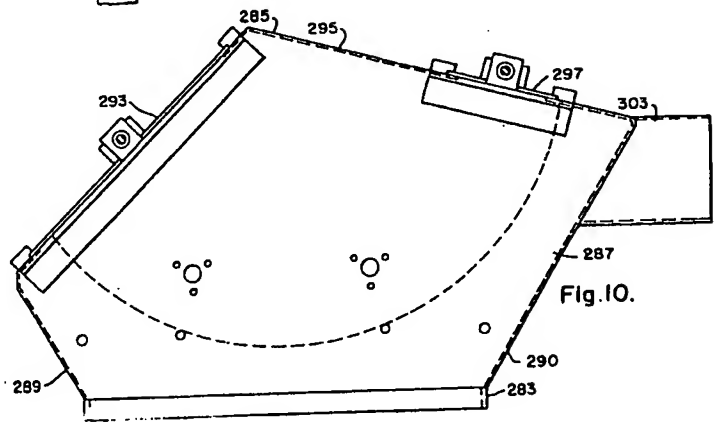


Fig.11.



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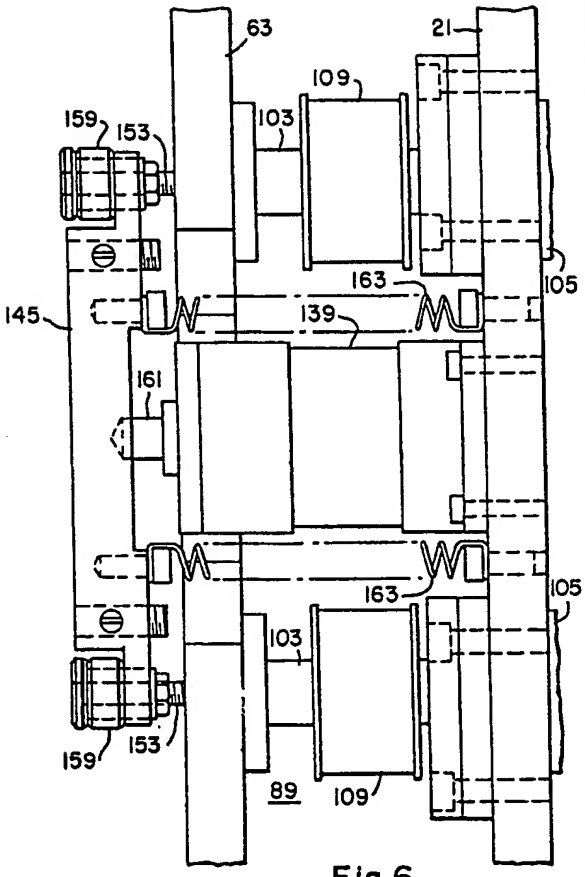
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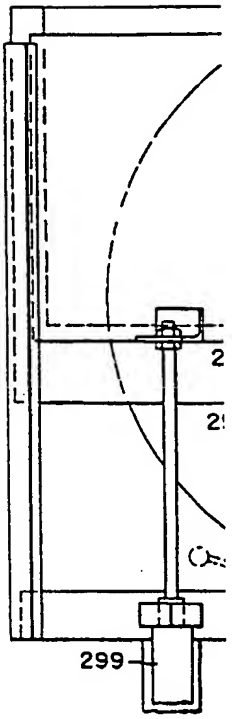
Fig.6.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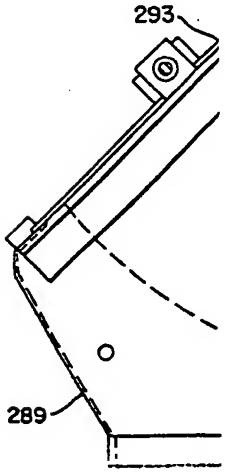
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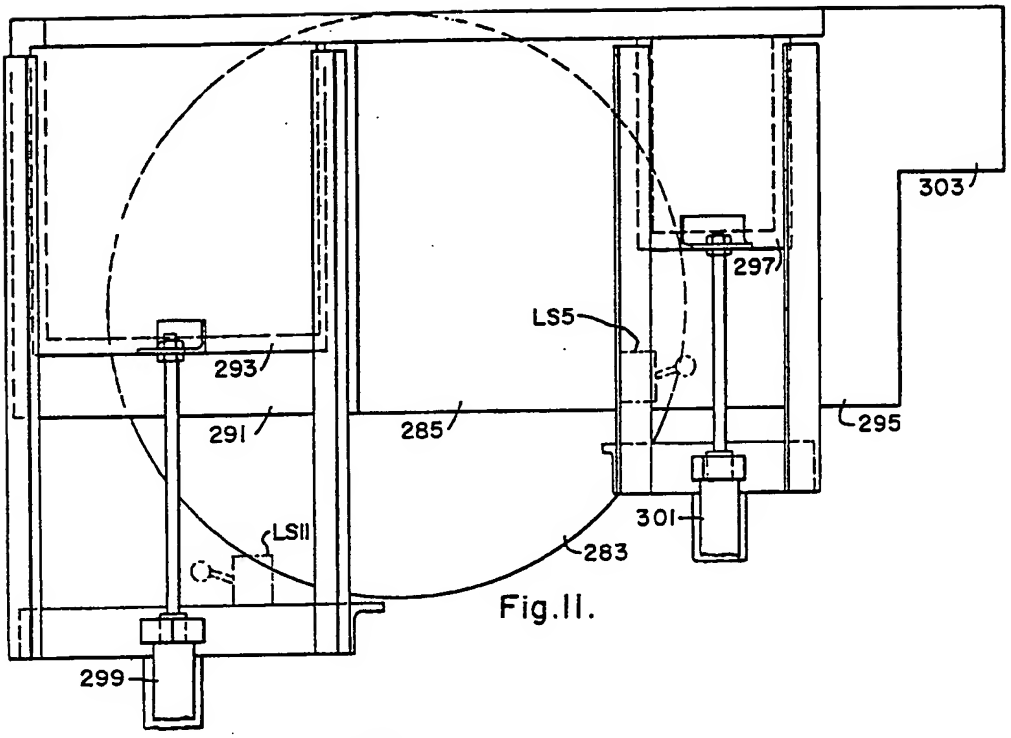
1001030 COMPLETE SPECIFICATION
6 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 4



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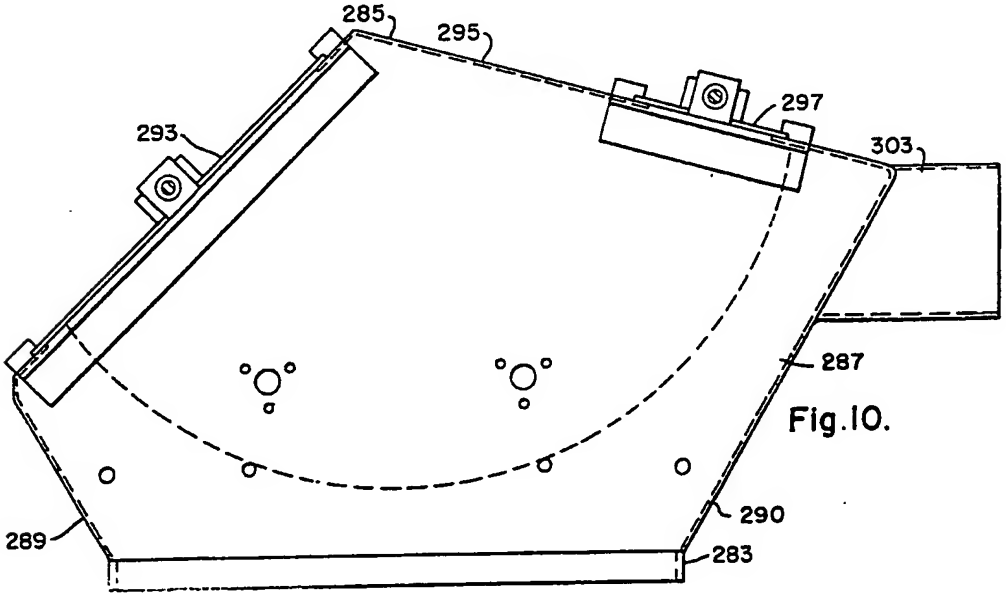
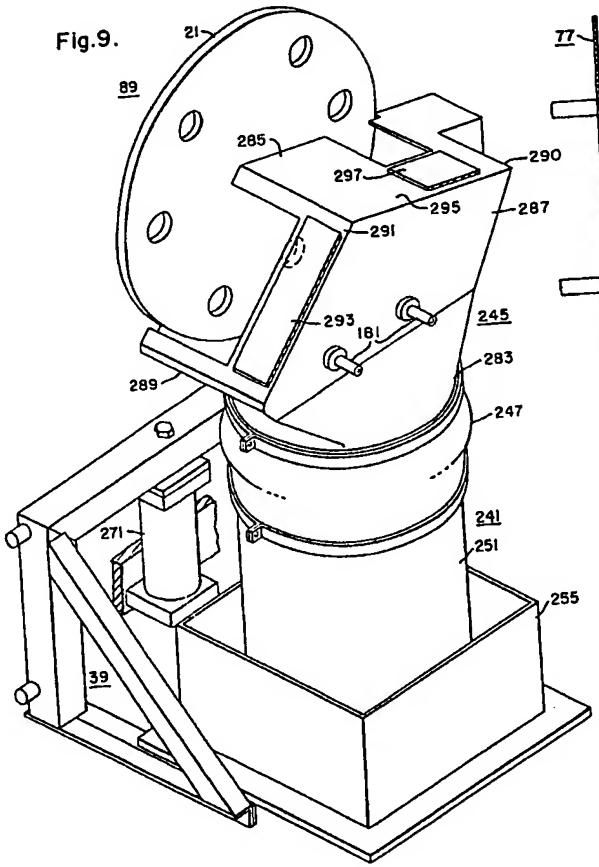


Fig.10.

1001030 COMPLETE SPECIFICATION
6 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 5

Fig.9.



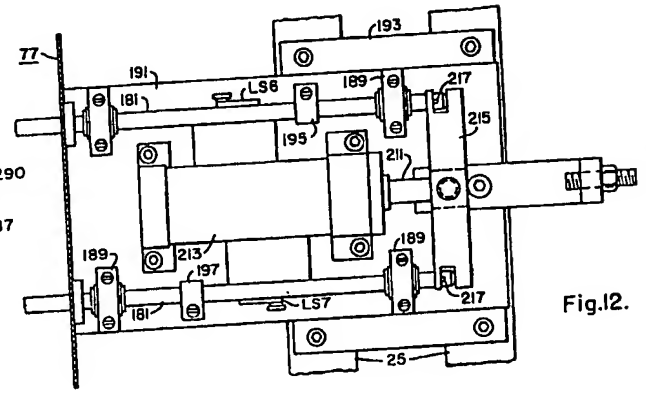
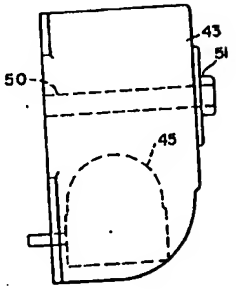


Fig.12.

Fig.8.



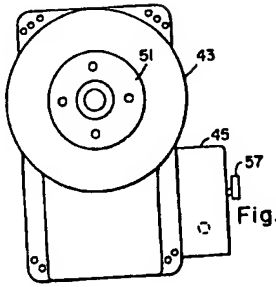
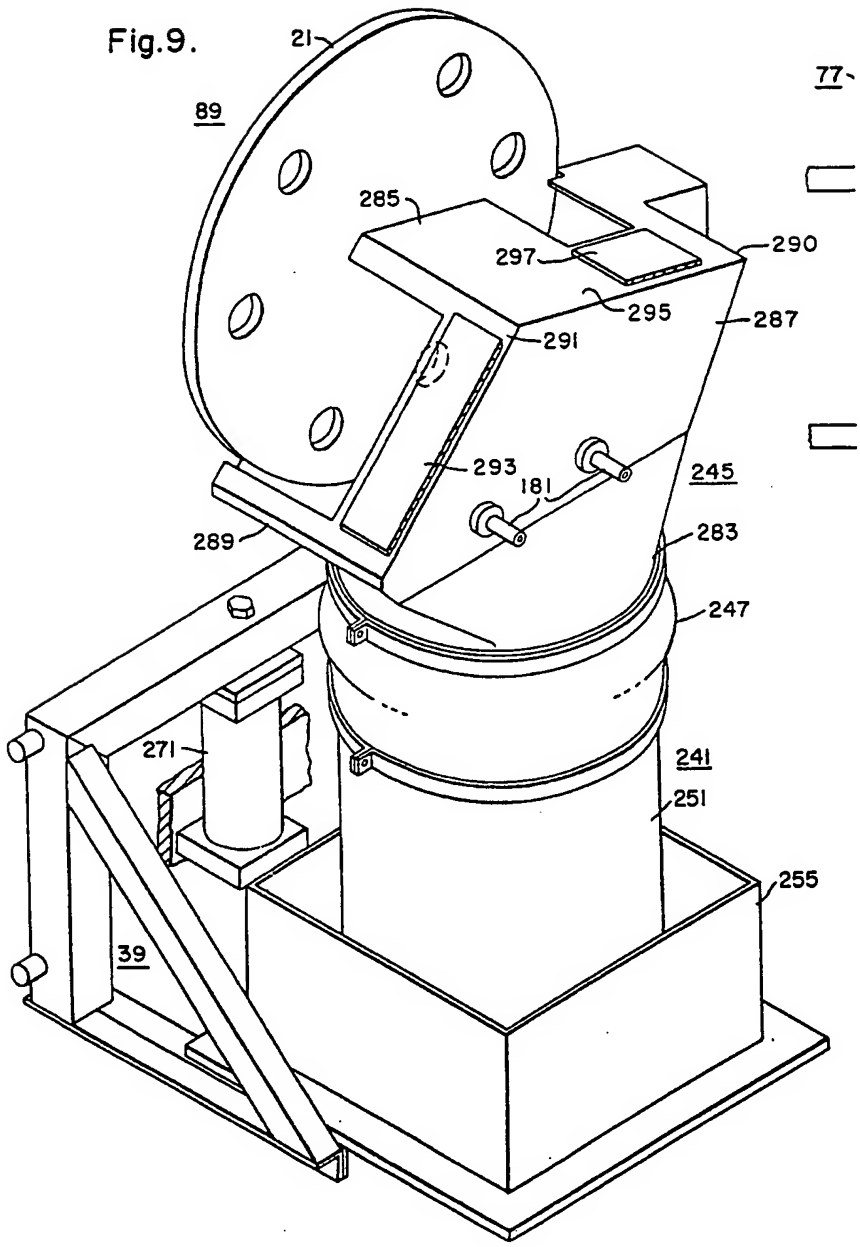


Fig. 7.

Fig.9.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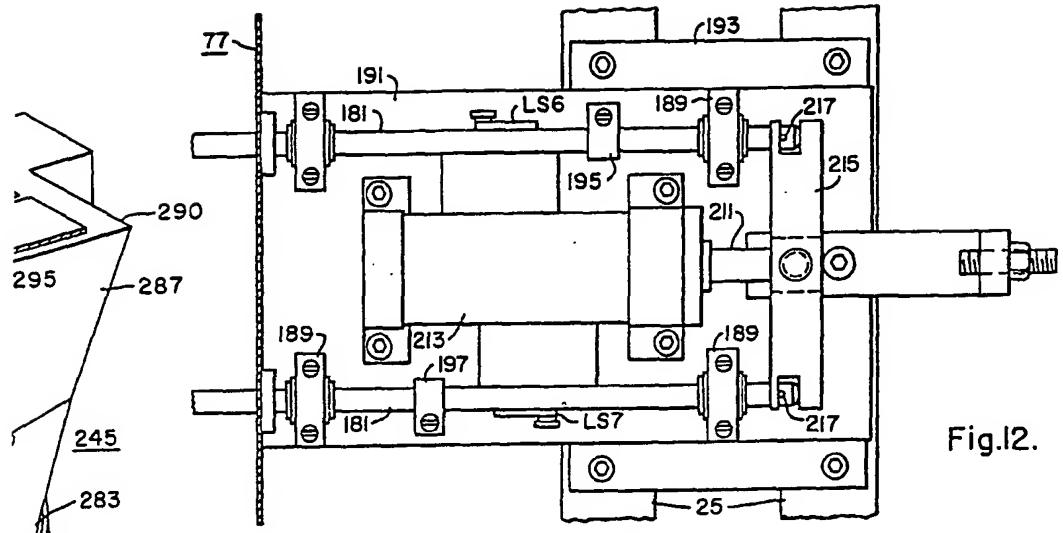
1001030 COMPLETE SPECIFICATION
6 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 5



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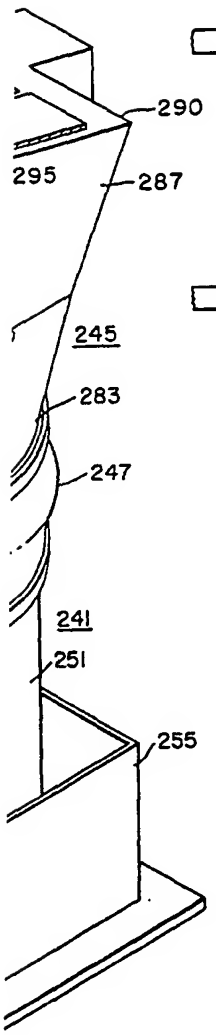


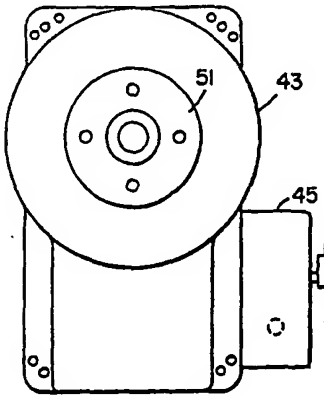
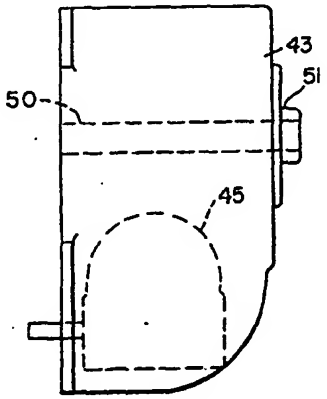


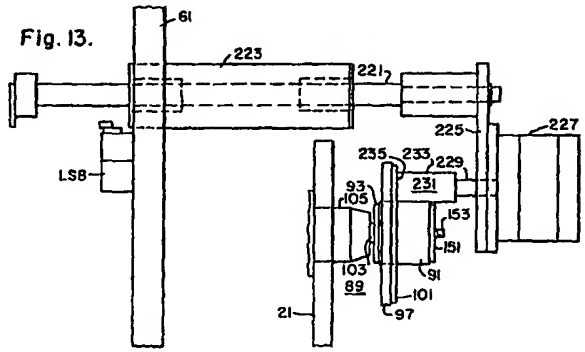
Fig. 7.

Fig.8.



1001030 COMPLETE SPECIFICATION
6 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 6

Fig. 13.



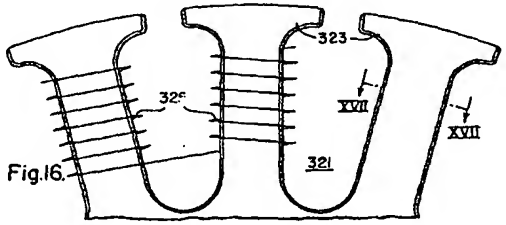


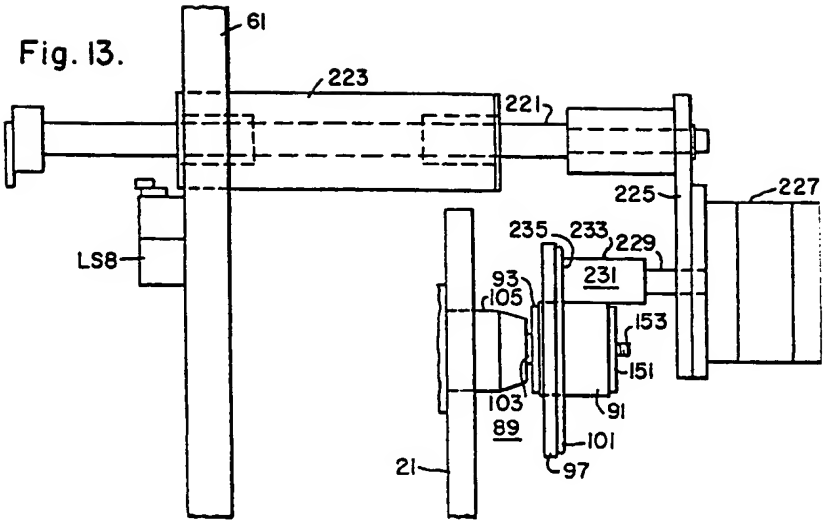
Fig.16.

Fig.17.

Fig.15.

						LS1	LS5			LS4						
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	1 & 9					O				O					O		
2	2 & 10	O	O				O			O		O			O		O
3	3 & 11	O	O	O	O					O		O	O		O		O
4	4 & 12	O	O		O					O	O	O			O		O
5	5 & 13	O		O	O					O		O	O		O		O
6	6 & 14	O								O	O	O			O		O
7	7 & 15							O				O					O
8	8 & 16								O			O					O

Fig. 13.



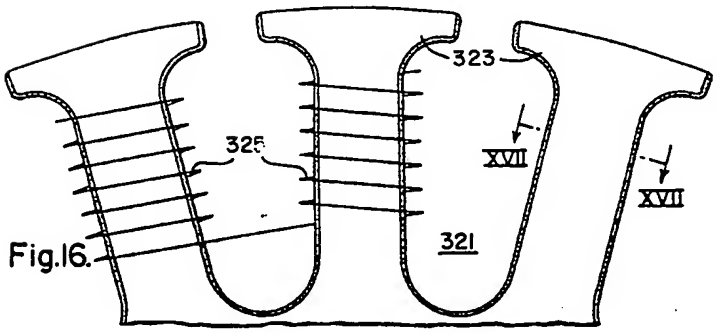


Fig.16.

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1001030 COMPLETE SPECIFICATION
6 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 6

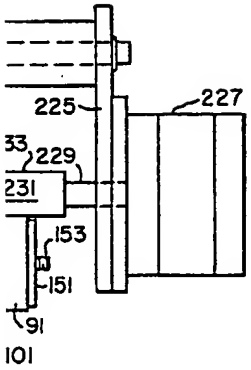
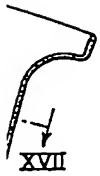


Fig.15.

Fig.17.



		LS1	LS5	LS4													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	1 & 9					O				O					O		
2	2 & 10	O	O				O			O		O			O		O
3	3 & 11	O	O	O	O					O		O	O		O		O
4	4 & 12	O	O		O					O	O	O			O		O
5	5 & 13	O		O	O					O		O	O		O		O
6	6 & 14	O								O	O	O			O		O
7	7 & 15							O				O					O
8	8 & 16								O			O					O